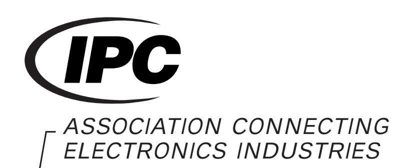


IPC-2514A

Sectional Requirements for Implementation of Printed Board Fabrication Data Description [BDFAB]

"The data model of this standard shall be in effect until 2001-12." At that time, the committee will consider changes, revision, other actions.

IPC-2514A
November 2000

A standard developed by IPC

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www.ipc.org

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- Minimize time to market
- Contain simple (simplified) language
- Just include spec information
- Focus on end product performance
- Include a feedback system on use and problems for future improvement

Standards Should Not:
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- Increase time-to-market
- Keep people out
- Increase cycle time
- Tell you how to make something
- Contain anything that cannot be defended with data

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Adopted October 6. 1998

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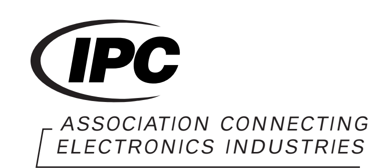
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IPC-2514A



[BDFAB]

Sectional Requirements for Implementation of Printed Board Fabrication Data Description

A standard developed by the Computerized Data Format Standardization Subcommittee (2-11) of the Data Generation and Transfer Committee (2-10) of the Institute for Interconnecting and Packaging Electronic Circuits.

The GenCAM format is intended to provide CAD-to-CAM, or CAM-to-CAM data transfer rules and parameters related to manufacturing printed boards and printed board assemblies. The requirements of IPC-2511 are a mandatory part of this sectional standard.

This standard is part of the GenCAM 1.5 release.

> **"The data model of this standard shall be in effect until 2001-12."** At that time, the committee will consider changes, revision, other actions.

Users of this standard are encouraged to participate in the development of future revisions.

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Acknowledgment

Any Standard involving a complex technology draws material from a vast number of sources. While the principal members of the IPC Data Generation and Transfer Committee of the IPC Data Transfer Solution DTS Subcommittee are shown below, it is not possible to include all of those who assisted in the evolution of this standard. To each of them, the members of the IPC extend their gratitude.

Data Generation and Transfer Committee

Chairman
Harry Parkinson
Digital Equipment

Data Transfer Solution DTS Subcommittee

Chairman
Harry Parkinson
Digital Equipment

Technical Liaisons of the IPC Board of Directors

Stan Plzak
Pensar Corp.

Peter Bigelow
Beaver Brook Circuits Inc.

Special Note of Thanks

Key Individuals — An executive group of personnel from different computer disciplines helped to make this document possible. To them and their dedication, the IPC extends appreciation and gratitude. These individuals are:

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Craig Carlson Stevermer, Infinite Graphics

Eric Swenson, Mitron Corporation

Sasha Wait, Myrus Design

William Williams IV, GenRad

TABLE OF CONTENTS

Sectional Requirements for Implementation of Printed Board Fabrication Data Description (BDFAB)

1 SCOPE

This standard specifies data formats used to describe drawing methodologies for printed boards and printed board assemblies. These formats may be used for transmitting information between a printed board designer and a printed board manufacturer.

The information can be used for both manual and for digital interpretations. The data may be defined in either English or SI units.

1.1 Interpretation

"**Shall**", the emphatic form of the verb, is used throughout this standard whenever a requirement is intended to express a provision that is mandatory. Deviation from a **shall** requirement is not permitted, and compliance test modules (CTMs) developed to check syntax and semantics, will prompt the user to correct the ambiguity, or to insert missing information.

The words "should" and "may" are used whenever it is necessary to express non-mandatory provisions.

"Will" is used to express a declaration of purpose.

To assist the reader, the word **shall** is presented in bold characters.

1.2 Board Fabrication Focus

The GenCAM format requirements are provided in a series of standards focused on printed board manufacturing, assembly, inspection, and testing. The generic standard, IPC-2511, contains general requirements and is a mandatory part of this standard, which provides requirements focused on printed board fabrication methodology. Suggested usage and examples for printed boards and panels are contained in this standard.

2 APPLICABLE DOCUMENTS

The following documents contain provisions which, through reference in this text, constitute provisions of IPC-2514. At the time of publication, the editions indicated were valid. All documents are subject to revision and parties to agreements based on this generic standard are encouraged to investigate the possibility of applying the most recent additions of the documents indicated below.

IPC-T-50		Terms and Definitions for Interconnecting and Packaging Electronic Circuits
IPC-2511	(MANGN)	Generic Requirements for Implementation of Product Manufacturing Description Data and Transfer Methodology
IPC-2512	(ADMIN)	Sectional Requirements for Implementation of Administrative Methods for Manufacturing Data Description
IPC-2513	(DRAWG)	Sectional Requirements for Implementation of Drawing Methods for Manufacturing Data Description

IPC-2515	(BDTST)	Sectional Requirements for Implementation of Bare Board Product Electrical Testing Data Description
IPC-2516	(BDASM)	Sectional Requirements for Implementation of Assembled Board Product Manufacturing Data Description
IPC-2517	(ASEMT)	Sectional Requirements for Implementation of Assembly In-Circuit Testing Data Description
IPC-2518	(PTLST)	Sectional Requirements for Implementation of Part List Product Data Description
IPC-2519	(MODEL)	Sectional Requirements for Information Model Data Related to the Printed Board and Printed Board Manufacturing Descriptions

3 REQUIREMENTS

The requirements of IPC-2511 are a mandatory part of this standard. That document describes the generic requirements for the GenCAM format.

The generic computer-aided design (GenCAM) format specifies details specifically for information interchange of data related to printed board manufacturing, assembly and test.

GenCAM is comprised of nineteen sections as described in the generic GenCAM standard, IPC-2511. The sections are shown in Tables 3-1 and 3-2 of the IPC-2511.

Each section has a specific function or task respectively and is independent of each other. Accordingly, the information interchange for a specific purpose is possible only if the sections required for such a purpose have been prepared.

3.1 Categories and Content

Table 3-1 provides the file names that are appropriate for the printed board fabrication processes. There are seven unique functions that can be defined by the use of these files of the GenCAM system.

Table 3-1 indicates the relationships of the requirements for various files within the descriptions for a particular process. The letter **"M"** signifies a *mandatory* requirements. The letter **"O"** signifies an *optional* characteristic that may or may not be pertinent to the particular file. A dash signifies an extraneous section (unnecessary); CTMs will not reject file summaries if extraneous sections are present.

The table signifies two requirement conditions separated by a "/". The first representation of requirements is intended to convey those GenCAM sections that **shall** be available as the initial input to the administrative processes. The second instance of a requirement is to signify those data that **shall** be available once the processing descriptions have been completed.

Table 3-1 GenCAM Section Relationships for Board Fabrication

File Identifiers	Board Fabrication	Panel Fabrication	Assembly Panel Fabrication	Phototools	Solder Paste Stencil
HEADERS	M/M	M/M	M/M	M/M	M/M
ADMINISTRATION	M/M	M/M	M/M	M/M	M/M
PRIMITIVES	M/M	M/M	M/M	M/M	M/M
ARTWORKS	M/M	M/M	M/M	M/M	M/M
LAYERS	M/M	M/M	M/M	M/M	M/M
PADSTACKS	M/M	M/M	M/M	M/M	M/M
PATTERNS	M/M	M/M	M/M	M/M	M/M
PACKAGES	-/-	-/-	-/-	-/-	-/-
FAMILIES	-/-	-/-	-/-	-/-	-/-
DEVICES	-/-	-/-	-/-	-/-	-/-
MECHANICALS	-/-	-/-	-/-	-/-	-/-
COMPONENTS	M/M	M/M	M/M	M/M	M/M
ROUTES	M/M	M/M	M/M	M/M	-/-
POWER	-/-	-/-	-/-	-/-	-/-
TESTCONNECTS	-/-	-/-	-/-	-/-	-/-
BOARDS	M/M	M/M	M/M	M/M	M/M
PANELS	O/O	M/M	O/M	O/O	O/M
FIXTURES	-/O	-/O	-/O	O/O	-/M
DRAWINGS	M/O	M/O	M/O	M/O	-/O
CHANGES	-/O*	-/O*	-/O*	-/O*	-/O*

* The CHANGES section is used independently to alter previously sent files. Included shall be a HEADER section (for revision status and identification) and an ADMINISTRATION section to show effectivity

The correlation between the various descriptions identified in this standard are indicated in Figure 3-1. This shows the relationship of test coupons, individual board, phototools, etc.

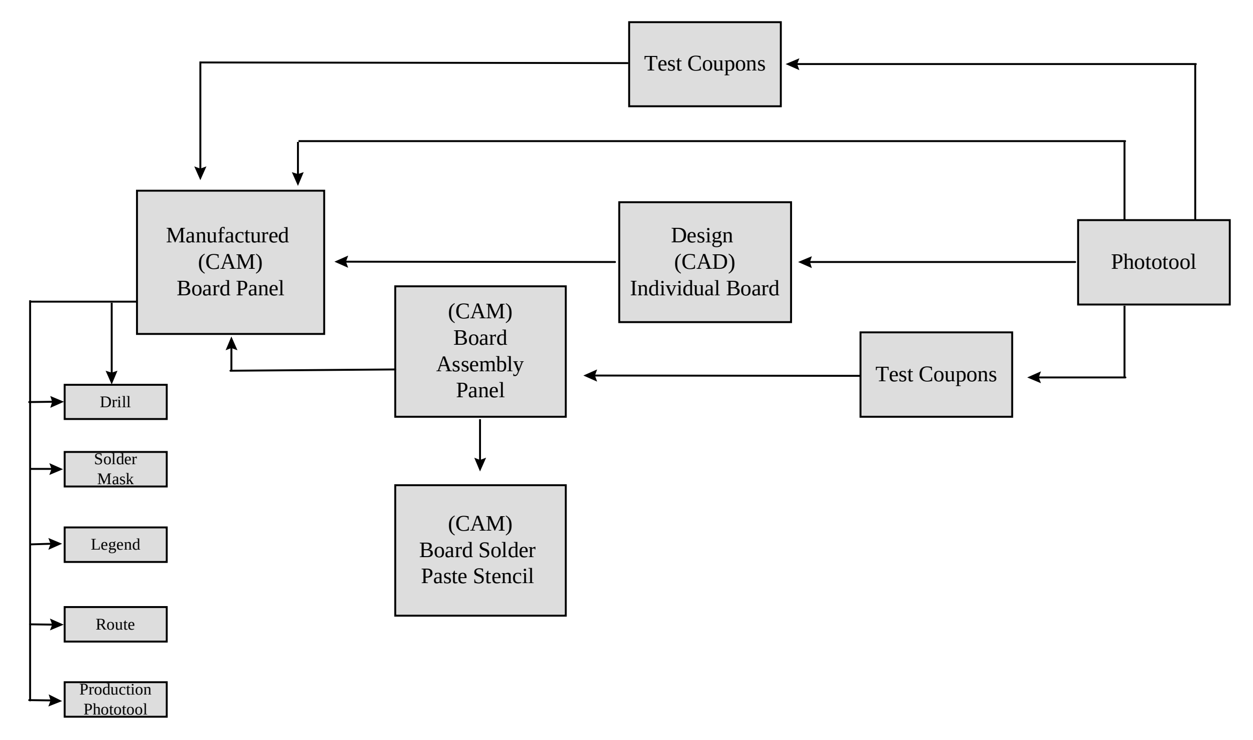


Figure 3-1 Board Fabrication Data Relationship

4 GENERAL RULES

The following details reflect the rules used in GenCAM to meet the requirements for board fabrication. These rules are intended to meet the needs of the manufacturer to understand the customer requirements.

Wherever necessary, additional requirements have been detailed to reflect precision. The attributes and rules for GenCAM described in IPC-2511 are required.

Wherever necessary, detailed descriptions or definitions of the entities, attributes or characteristics are described according to the following issues detailed in Table 4-1 and descriptions.

Table 4-1 Keyword/Attribute Relationship

Need Identifier	Keyword/Section	Keyword Usage
Drill data	HOLEREF	Associated with padstacks
X-Y location	<position>, <xy_ref>, <location>,.<placement>	Last parameter for drawables
Diameter	HOLEDEF.<primitive_ref>	Used for lands in padstacks
Hole type (NPTH or PTH)	HOLEDEF.<hole_type>	Defines hole type
Layer association	HOLEDEF.<layers_ref>	Identifies layer order and type
Tooling holes	HOLEDEF.<hole_type>	Hole-type (tooling)
Hole usage	HOLEDEF.<hole_type>	Describes conductors and vias
Conductor definition	ROUTES	Describes conductors and vias
Layer	LAYERS	Conductive and non-conductive layers
Line end	LINEDESC.<line_end>	Defines line ends
Conductor	ROUTES	Path and plane conductors
Land	PATTERNDEF	Collections of pads drawn in components

Need Identifier	Keyword/Section	Keyword Usage
Card outline	OUTLINE	Physical outline of the board or panel
Cutouts	CUTOUT	Part of BOARD, PANEL, and FIXTURE definition
Notches	GROOVE	Part of BOARD, PANEL, and FIXTURE definition
Milled thickness	WELL	Part of BOARD, PANEL, and FIXTURE definition
Special features	FEATURE	Specialized artwork
Fiducials	TARGET	A special artwork used for alignment (standard)
Bad board marks	TARGET	User-defined primitive
Legend	TEXT	Text primitives (text box)
Reference designators	TEXT	Text primitives (text box)
U.L. rating symbol	LOGO	User-defined primitive
Logos	LOGO	User-defined primitive
Part numbers, etc	BOARD.<board_number>	Can be drawn using Text primitives (text box)
Datum features	TARGET	Target (standard primitive)
Panelization	OUTLINE, GROOVE	xy reference
Global fiducials	TARGET	A special artwork used for alignment (standard)
Non-conductor definition	LAYERSINGLE.<GenCAM_layer_type>	DIELBASE, DIELCORE, or DIELPREG
Solder mask	LAYERSINGLE.<GenCAM_layer_type>	SOLDERMASK
Layer sequence	LAYERSINGLE, LAYERSET	Layer set name followed by 1 to "n" layers
Dielectric thickness and materials	LAYERSINGLE.<thickness>, LAYERSINGLE.<material>	Part of parameters for layer type
Copper weights and materials	LAYERSINGLE.<material_code>	Part of layer description
Finish	LAYERSINGLE.<GenCAM_layer_type>	COATINGCOND or COATINGNONCOND
Overall thickness	LAYERSET.<thickness>	Desired finished thickness of the layerset

5 MODELING

The data files of GenCAM may be mapped to the information models. Information models are developed to ensure that complete mapping is capable between the information provided within the GenCAM characteristics. The correlation is provided in the activity models shown in IPC-2519.

All data activities are based on activity models as defined in IPC-2519. The activity models covered by CAD and CAM include the engineering, design, administrative, and fabrication and assembly characteristics. Each of these sections are intended to be detailed into various levels of activity much like layers of information needed to perform a particular manufacturing process.

Figure 5-1 shows the activity needed to develop board fabrication data.

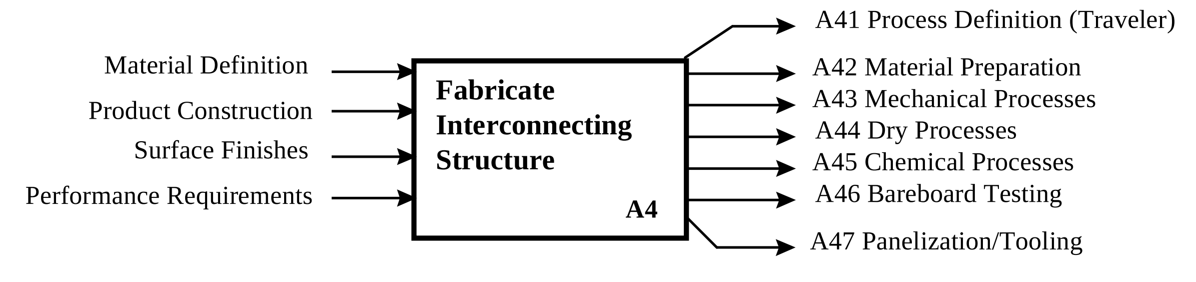


Figure 5-1 Printed Board Fabrication Activity

5.1 Information Models

Information models are also helpful in understanding the requirements of the board fabrication section. Attribute information is correlated to the parameters of GenCAM as well as to the activity models used to describe board fabrication data.

EXPRESS is an international information modeling format supported by ISO 10303-11. The graphic representation of EXPRESS is known as EXPRESS-G. Appendix A provides an explanation of the different EXPRESS-G requirements. Figures 5-2 through 5-9 show the EXPRESS-G version of the GenCAM BOARDS, PANELS and ROUTES sections. See www.gencam.org for the complete EXPRESS-G model.

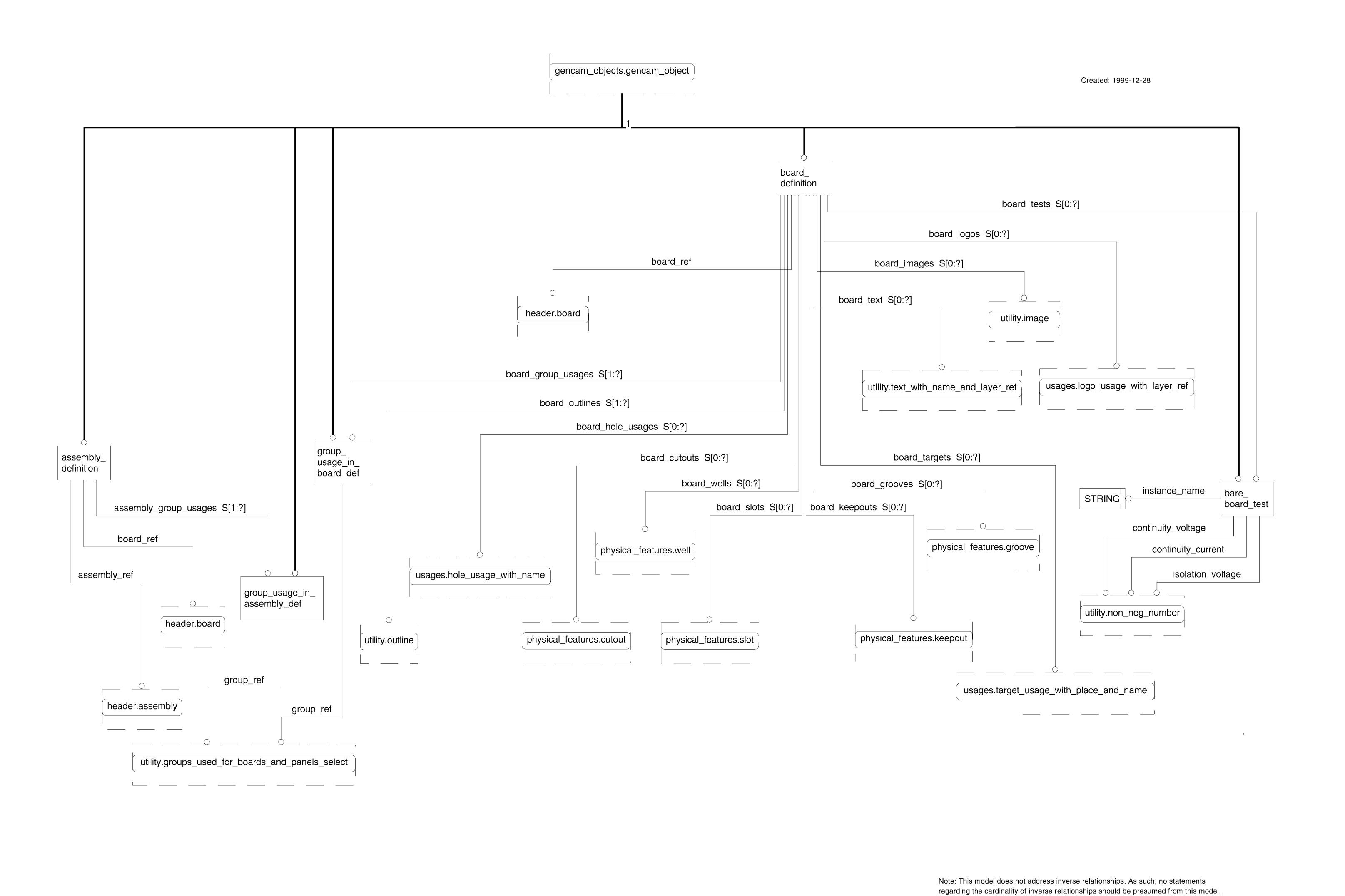


Figure 5-2 EXPRESS-G for BOARDS

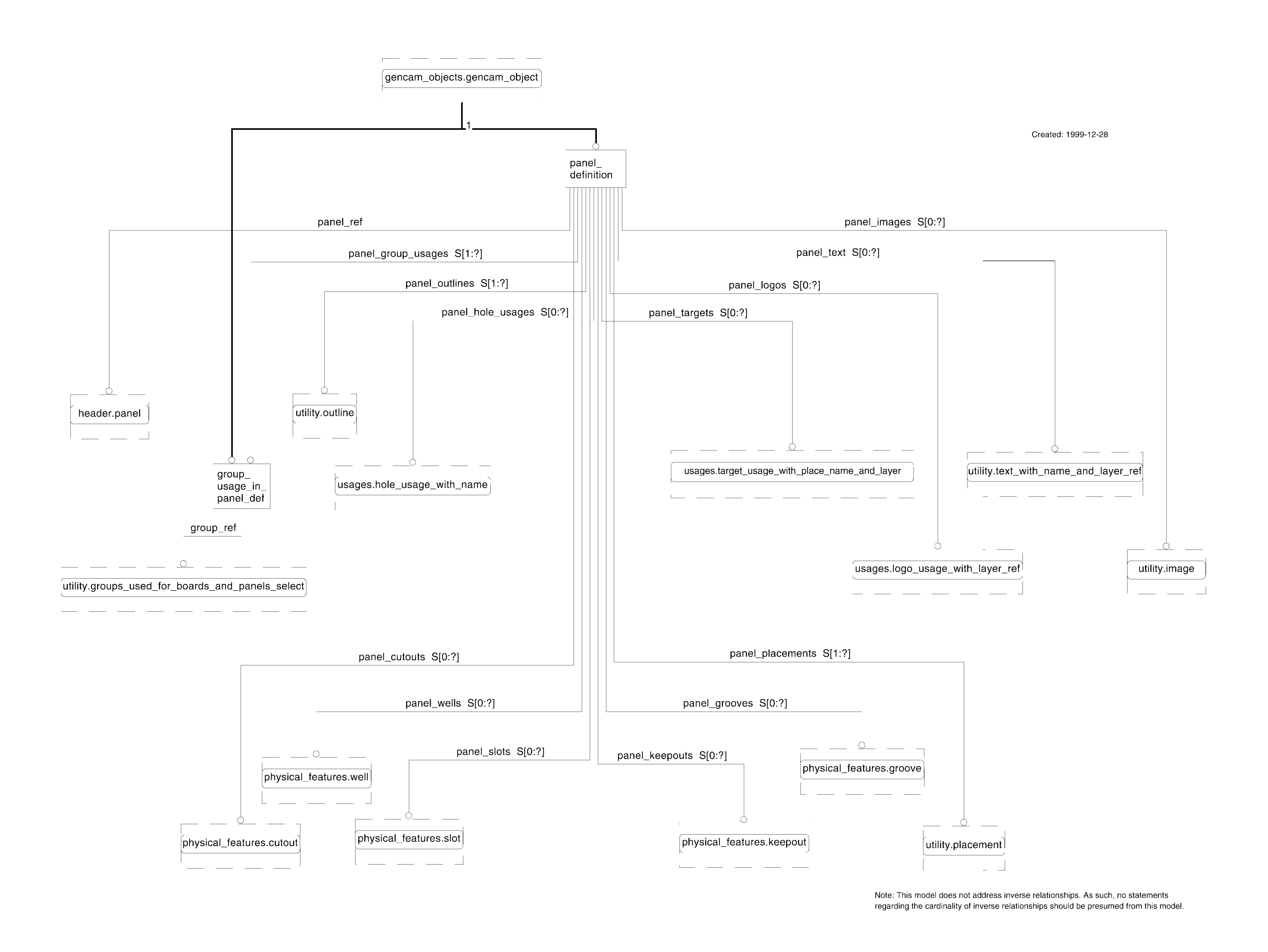


Figure 5-3 EXPRESS-G for PANELS

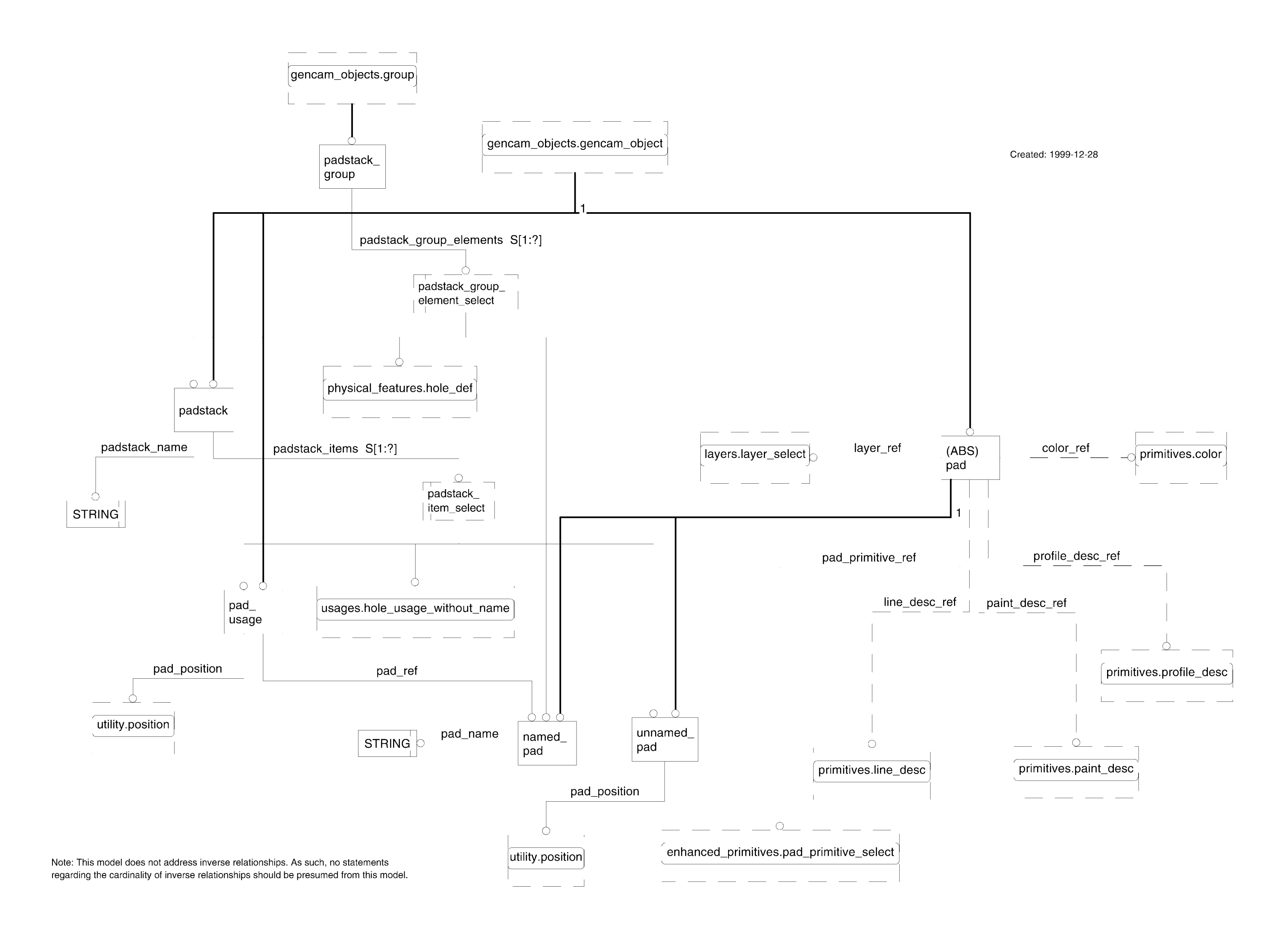


Figure 5-4 EXPRESS-G for PADSTACKS

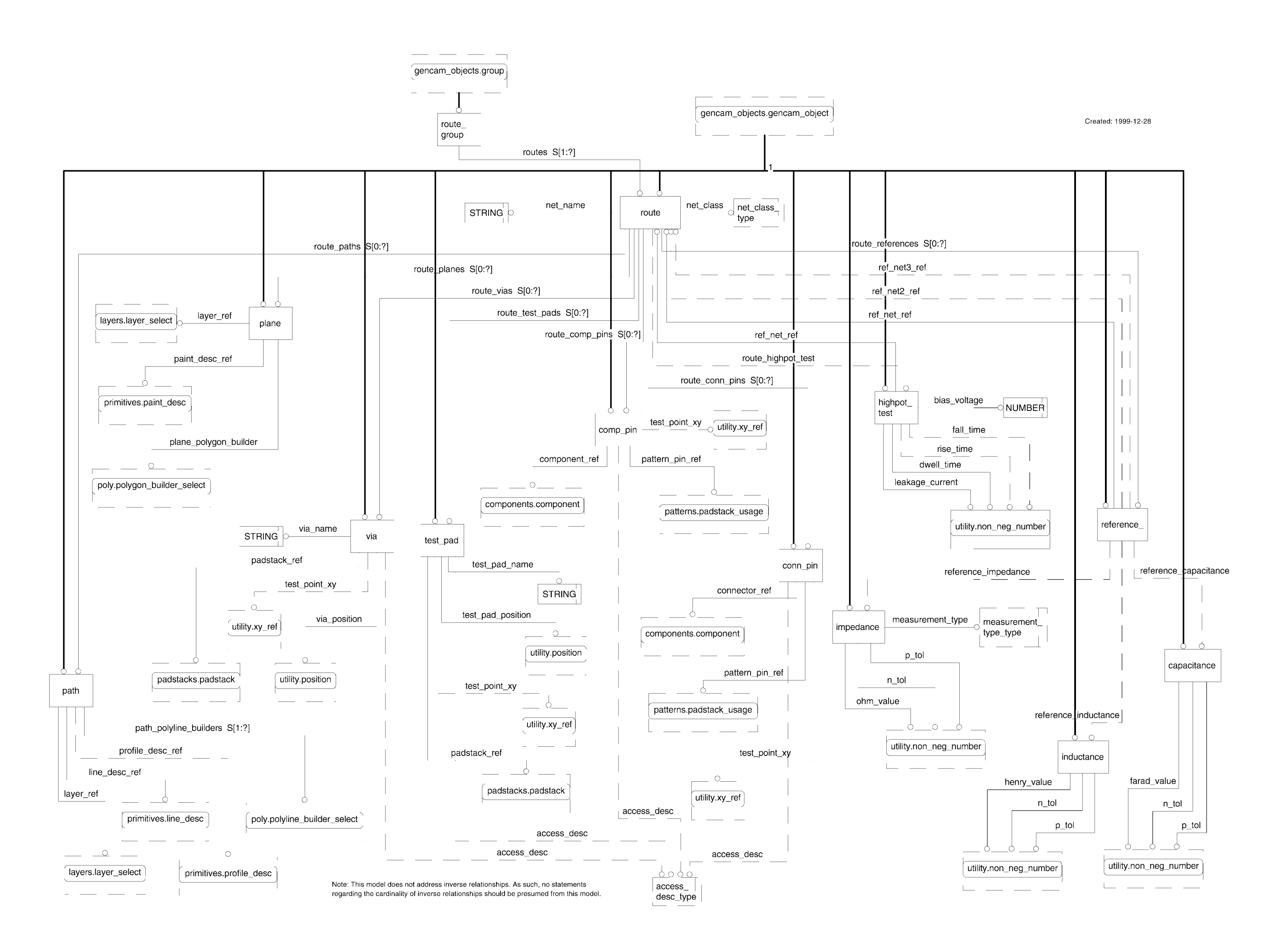


Figure 5-5 EXPRESS-G for ROUTES

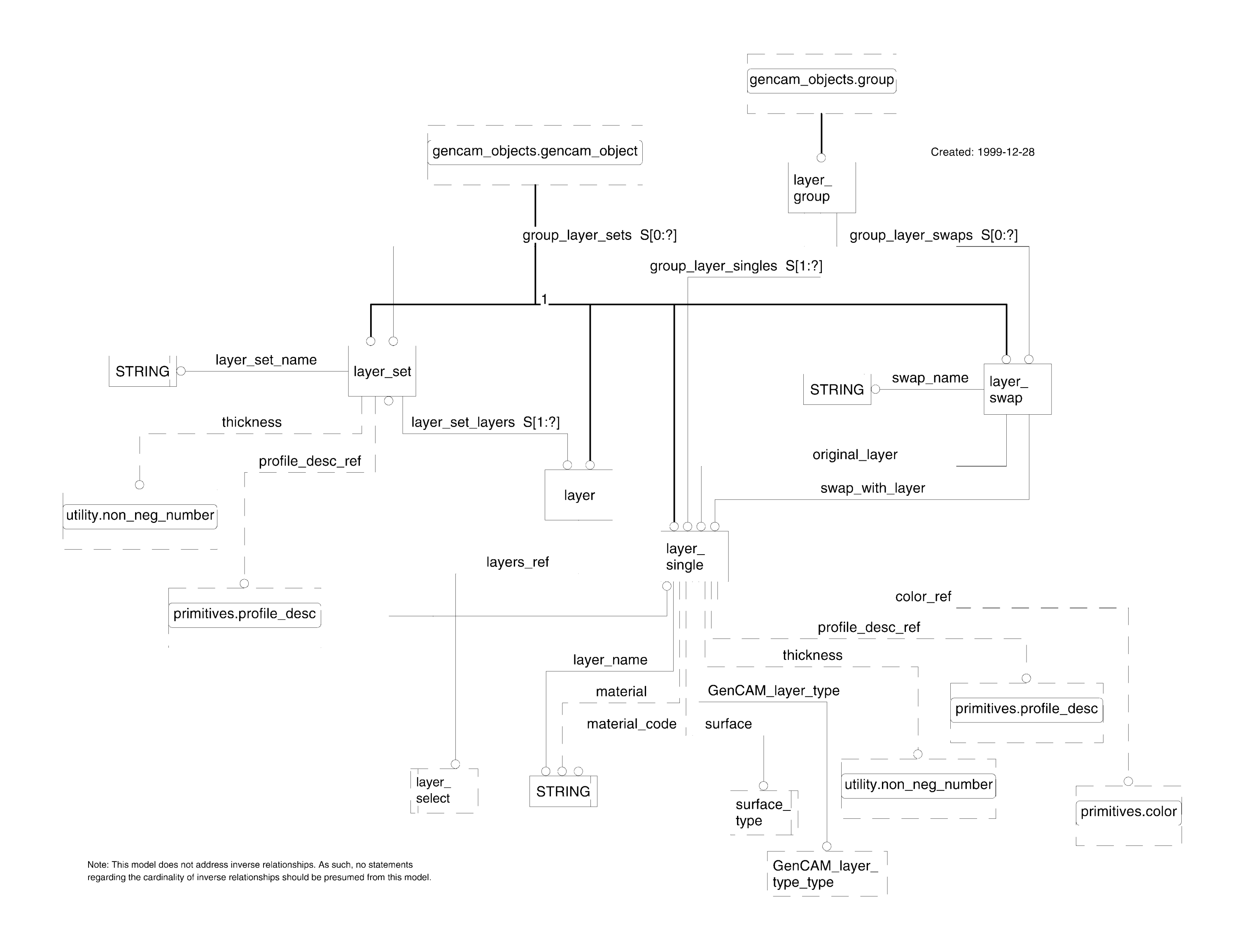


Figure 5-6 EXPRESS-G for LAYERS

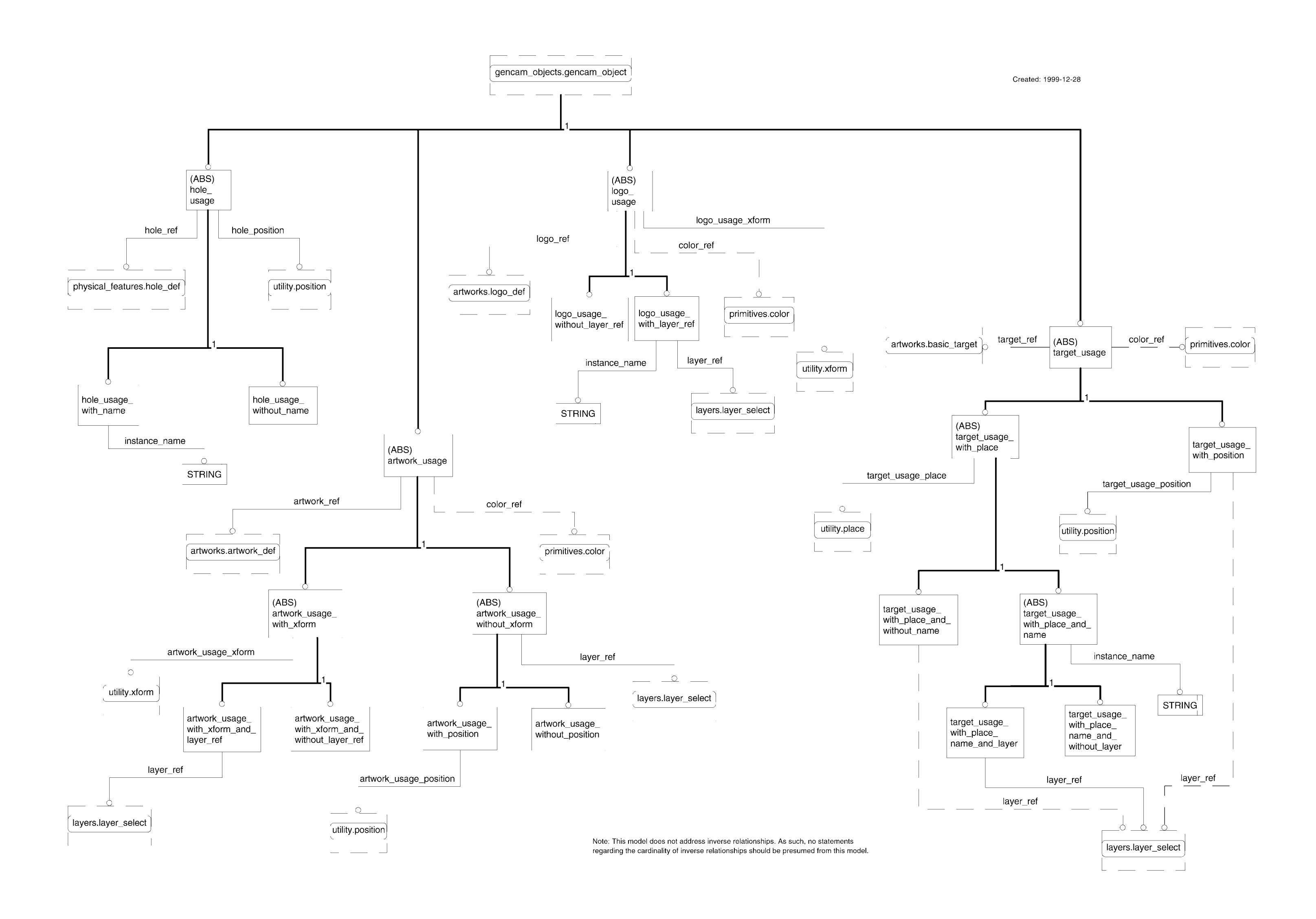


Figure 5-7 EXPRESS-G for BOARD/PANEL objects

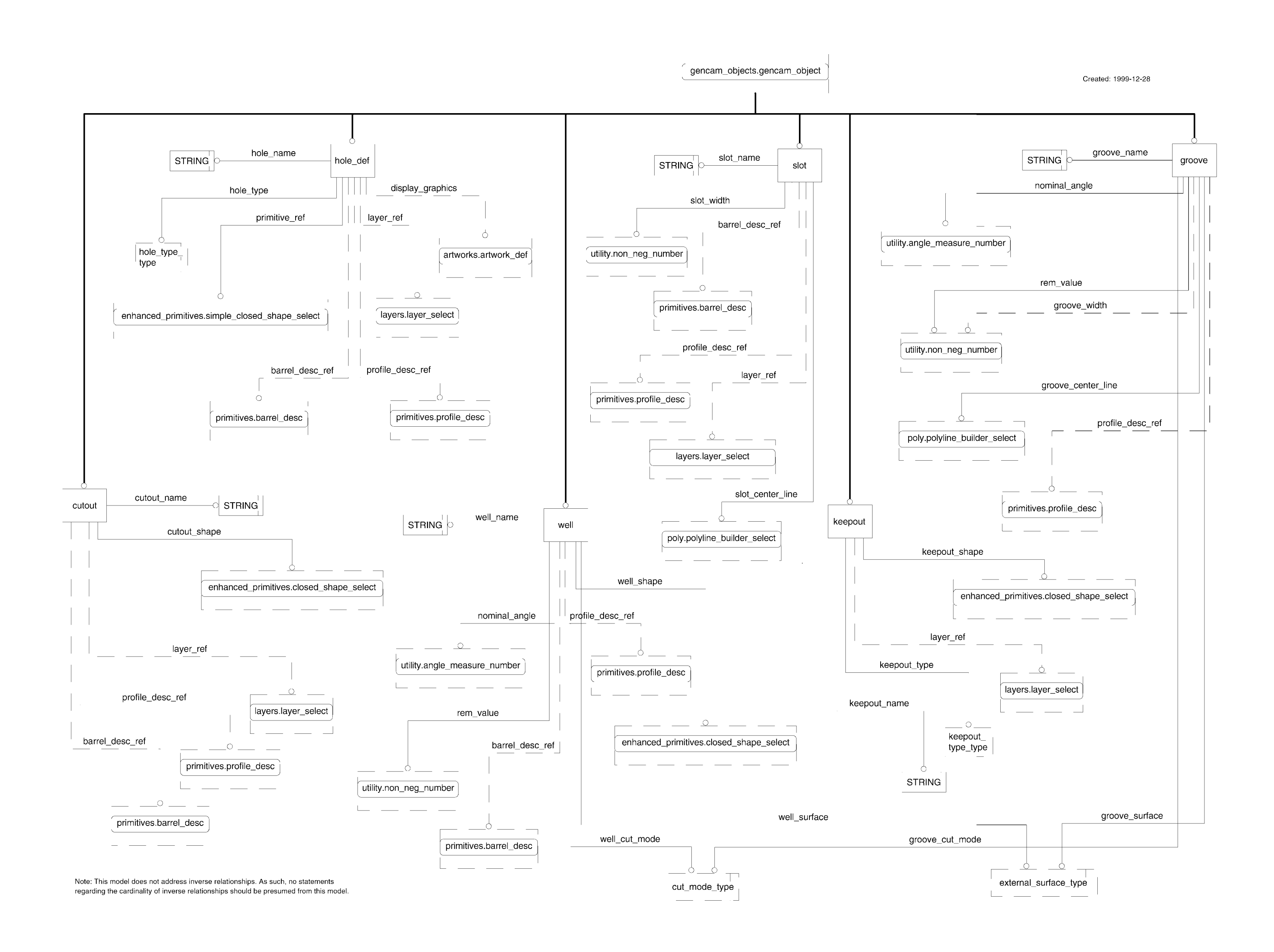


Figure 5-8 EXPRESS-G for BOARD features

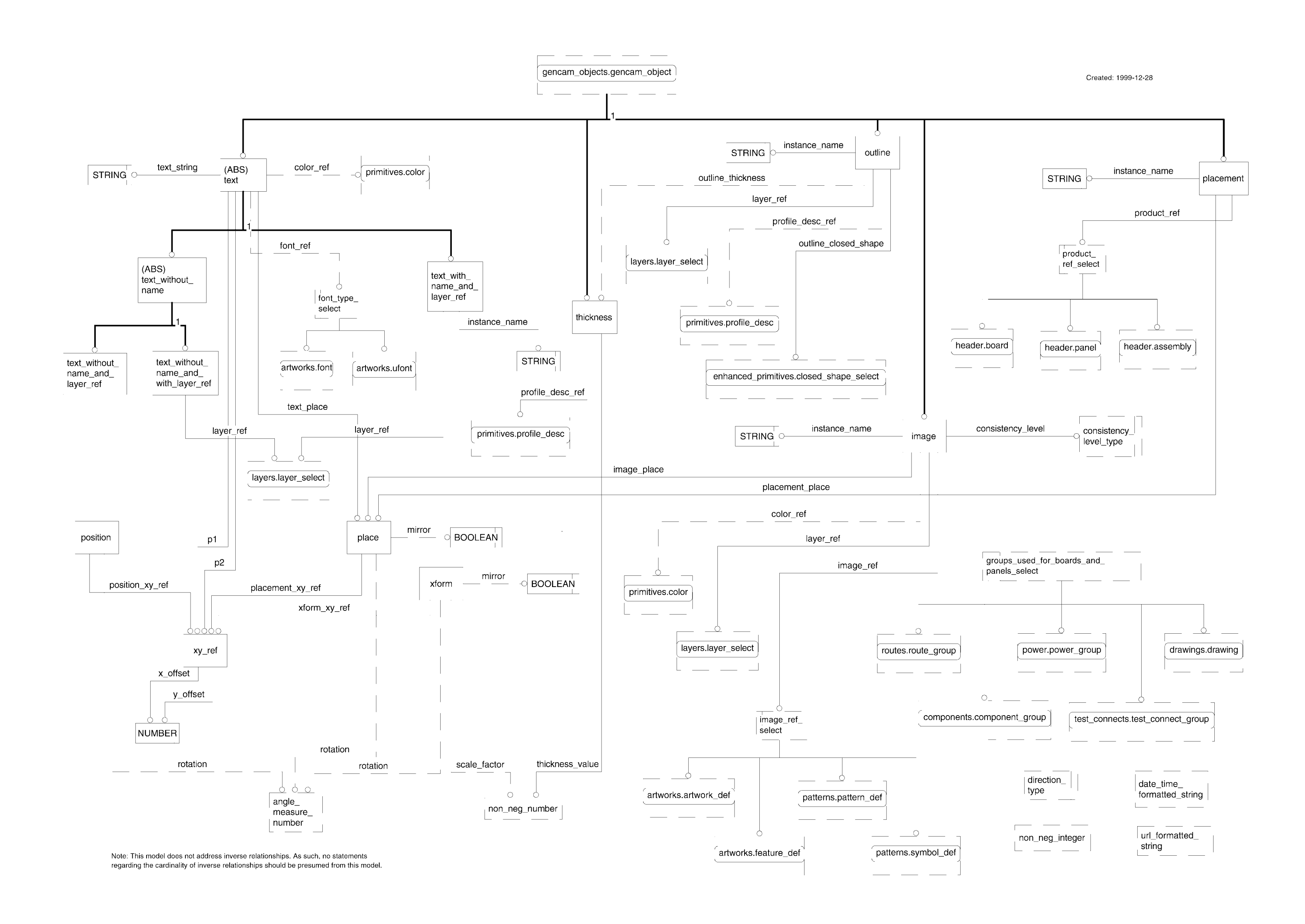


Figure 5-9 EXPRESS-G for BOARD to PANEL

6 REPORT GENERATORS

Each of the sections of the GenCAM format has various report generators that industry uses to provide the user with hard copy of the GenCAM data file. Some of them are preferred based on industry preferences, others are mainly examples. The detailed report generators are described in each of the seven sections of the sectional documents i.e. IEC 2512 - 2518.

6.1 Hole Usage Report

HOLE SIZE USAGE

Hole Size	Hole count	Type	Usage tooling
0.157	4	NPTH	Tooling
0.020	40	PTH	Electrical
0.035	65	PTH	Electrical
0.041	120	PTH	Electrical
0.125	8	NPTH	Mechanical
Total	237		

6.2 Pad Usage Report

PAD USAGE

X	Y	Count	Pad
0.040	0.040	40	Fiducial
0.055	0.055	65	Componet1
0.030	0.076	20	SOIC1

6.3 Conductor Usage Report

CONDUCTOR USAGE
0.006
0.008
0.025
0.125

7 REFERENCE INFORMATION

The following sections define reference documents that are useful in clarifying the products or process of the industry or provide additional insight into the subject of data modeling or released information models.

7.1 IPC (1)

IPC-T-50 Terms and Definitions
IPC-D-275 Design Standard for Rigid Printed Boards and Rigid Printed Board Assemblies
IPC-D-300 Printed Board Dimensions and Tolerances
IPC-D-310 Guidelines for Artwork Generation and Measurement Techniques for Printed Circuits
IPC-D-325 Documentation Requirements for Printed Boards, Assemblies and Support Drawings

7.2 American National Standards Institute (2)

ANSI X3/TR-1-77 American National Dictionary for Information Processing
ANSI X3.12 Subroutine Record Format Standardization
ANSI Y14.5 Dimensioning and Tolerancing for Engineering Drawing
ANSI Y32.1 Logic Diagram Standards
ANSI Y32.16 Electrical and Electrical Reference Designators
ANSI Z210.1 Metric Practice Guide (ASTM 380-72)

7.3 Department of Defense (3)

DoD-STD-100 Engineering Drawings

7.4 Electronic Industries Association (4)

EDIF 4 0 0 Electronic Data Interchange Format

7.5 International Organization for Standards (ISO)

ISO STEP Documentation

AP210	Electronic Printed Circuit Assembly: Drawings and Manufacturing
AP211	Electronic PC Assembly, Test Diagnostics & Remanufacture
AP221	Process Plant Functional Data & Schematic Representation

Appendix A

EXPRESS defines data objects and their relationships among data objects for a domain of interests. Some typical applications of data models include supporting the development of databases and enabling the exchange of data for a particular area of interest. As an example, a specific requirement of a database for an audio compact disc (CD) collection is shown in Figure 1.

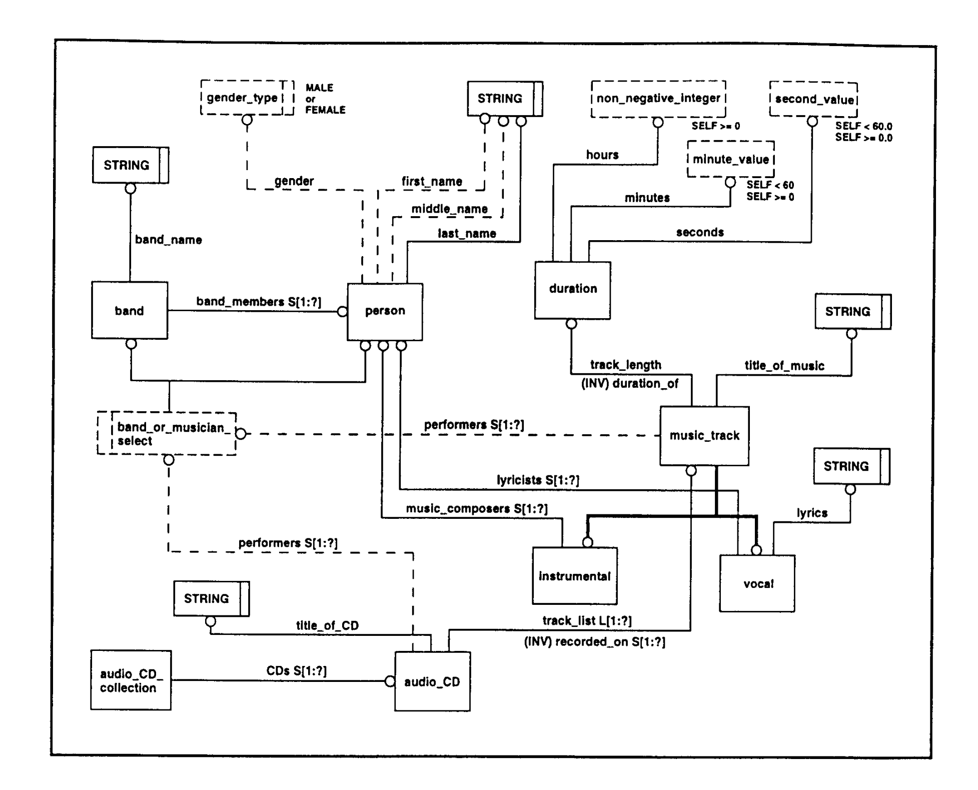


Figure A-1 Example of EXPRESS-G Model

Data models are specified in a data modeling language. EXPRESS is a data modeling language defined in ISO 10303-11. One of the advantages of using EXPRESS-G over EXPRESS is that the structure of a data model can be more intuitively presented. A disadvantage of EXPRESS-G is that complex constraints cannot be formally specified. There are specific symbols used in EXPRESS-G notation. The meaning of those symbols is defined in the EXPRESS formatting.